repeated for each substrate of the lead frame, the die bonding method comprises: after discharge of the adhesive agent, initially using a first velocity for moving the substrate and needle apart; and thereafter using a second velocity for moving them further apart, the second velocity being greater than the first velocity.

In operation, the adhesive agent is discharged from the needle onto a substrate. Thereafter, the needle and the substrate are moved apart at a low first velocity. Therefore, stringing of the adhesive agent is suppressed with ready separation of the adhesive agent toward the needle and substrate sides. The needle and the substrate are then moved apart further at a second velocity greater than the first velocity. Discharge of the adhesive agent onto a substrate can be completed without lengthening of the cycle operation time, and with the suppression of stringing of the adhesive agent. Therefore, various types of materials can be used as the adhesive agent.

According to the present invention, adhesive agent can be discharged onto a substrate without lengthening the cycle operation time and with the suppression of stringing of the adhesive agent to therefore allowing a high production efficiency and semiconductor devices with high reliability.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. **1** is a needle up/down displacement chart showing the up/down movement of a needle, according to an embodiment of this invention;

FIG. **1A** is a needle up/down displacement chart showing a test result for this invention;

FIG. **2** is a perspective view of a die bonding apparatus;

FIG. **2A** is a partial, enlarged view of Fig. **2**;

FIG. **3** is a needle up/down displacement chart showing the up/down movement of a needle, according to the prior art; and

FIG. **4** illustrates stringing of the adhesive gent as encountered in the prior art method.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1** is a needle displacement chart showing the up/down movement of the needle **15***a*, and is used to explain an embodiment of this invention. As can be seen from FIG. **1**, one cycle of the up/down movement of the needle **15***a* is performed upon uniform rotation by an angle θ of the cam fixed on the rotary shaft of the motor **13**. This angle θ is equal to the angle θ used in the conventional method shown in FIG. **3** for rotation of the cam necessary for one cycle of the up/down movement of the needle **15***a*. The downward movement of the needle **15***a* is carried out by a rotation of the cam by an angle θ_a' smaller than the angle θ_a shown in FIG. **3**. The displacement curve of the needle **15***a* moving downward is a cycloidal curve. The upward movement of the needle **15***a* is carried out by rotation of the cam by an angle θ_b' larger than the angle θ_b shown in FIG. **3**. Upon rotation by an angle θ_{b1}' at the leading portion of the angle θ_b', it is so arranged that the needle **15***a* is moved upward at an uniform velocity to the height **S1** at the midway of displacement S, to trace a uniform velocity curve. Namely, this upward movement velocity is set at slower than that shown in FIG. **3** so that the amount of stringing of the conductive adhesive agent becomes less to the extent that it is readily cut and separated toward the needle **15***a* and substrate **2***a* sides so as not to fall down onto the undesired area (the area where the adhesive agent should not be applied) of the substrate **2***a*. Upon rotation by an angle θ_{b2}'at the trailing portion of the angle θ_b', it is so arranged that the needle **15***a* is rapidly moved further upward by the remaining height **S2** to trace a steeper θ cycloidal curve. This is because the upward movement in this case is performed after the adhesive agent has been cut and separated, thus allowing such a high velocity. With the above arrangement, it becomes possible to discharge and apply the adhesive agent onto a substrate **2***a* without any stringing occurring. Because of this, it is possible to use adhesive agents of materials that could not be used because of stringing occurring with conventional methods.

In addition, the rotation angle θ of the cam necessary for the up/down movement of the needle **15***a* through displacement S is the same as those for both the present (FIG. **1**) and conventional (FIG. **3**) methods. Therefore, in the above embodiment of this invention, one cycle of discharge and application operation of an adhesive agent can be performed within the same time as that in the conventional method.

The cam (or z-direction drive motor **13**) is made to rotate at a uniform velocity in the above embodiment. However, instead of the embodiment cam, a unfirom velocity cam may be used by rotating it at a variable velocity by motor **13** to obtain the same displacement curve as shown in FIG. **1**.

FIG. **1A** is a cam timing chart (needle up/down displacement chart) illustrating the results of tests carried out by the inventors for this invention. In the experiment, epoxy resin having a viscosity of 100 to 300 PS was used. As seen from this timing chart, while rotating the cam by an angle θ_a'', the needle was first moved downward by 13 mm at a velocity (average velocity of 180 mm/sec) tracing a cycloidal curve. Next, while rotating the cam by an angle θ_c'', the needle was held at that position. Thereafter, while rotating the cam by an angle θ_{p1}'', the needle was moved upward by 4.5 mm at a velocity less than 40 mm/sec. tracing a uniform velocity line. Lastly, while rotating the cam by an angle θ_b'', the needle was moved upward by 8.5 mm at a velocity (average velocity of 100 mm/sec) tracing a cycloidal curve. By moving the needle as above, it was possible to make the amount of resin stringing small and to prevent unnecessary resin from falling down onto the substrate.

What is claimed is:

1. In a die bonding method wherein an adhesive agent with which a semiconductor chip is bonded to a substrate of a lead frame, is discharged from a needle of a die bonding apparatus to the substrate, thereafter the substrate and needle are moved apart and the above operation is repeated for each substrate of the lead frame, said die bonding method comprising: after discharge of said adhesive agent, initially using a first velocity for moving said substrate and needle apart; and thereafter using a second velocity for moving them apart, said second relative movement velocity being greater than said first relative movement velocity.

2. A die bonding method according to claim **1**, wherein said first velocity is a uniform velocity.

3. A die bonding method according to claim **1**, wherein said first velocity is a low velocity at which said adhesive agent can be prevented from stringing and falling onto an area of said substrate where said adhesive agent should not be applied.